# ON THE MODE OF ATTACHMENT OF THE LEAVES OR FRONDS TO THE CAUDEX IN *GLOSSOPTERIS*;

WITH

# REMARKS ON THE RELATION OF THE GENUS TO ITS ALLIES.

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## WITH A NOTE ON ITS STRATIGRAPHICAL DISTRIBUTION IN AUSTRALASIA.

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(Plates xviii.-xix.)

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## 1. Introduction.

The genus *Glossopteris* is probably familiar to those possessing but a limited knowledge of the Palæonotology of N.S. Wales. So intimately are the leaves or fronds of this plant, whichever the

reader may choose to call them, associated with the coal-bearing rocks of this country, "forming more than nine-tenths, and perhaps ninety-nine hundredths, of all the fossil bands of these regions,"* and so closely interwoven is the genus with the old dispute as to the age of our Coal-measures, that it seems almost superfluous to refer to its general structure. But the fortunate discovery of a more than ordinarily interesting specimen near Mudgee, by Mr. C. J. Horsley, J.P., showing the attachment of the fronds to the caudex, has necessitated a reconsideration of the entire history and structure of *Glossopteris*. More particularly is this the case, as there is only one previous authentic record, and a second less so, of the relation of these parts in the genus. The almost universal mode of occurrence is that of separate petiolate fronds, throughout the shales of our Coal-measures, either singly or in matted masses.

The exigencies of the Palæo-botanist necessitated the christening of these various forms of fronds with different names, often, no doubt, erroneously, as there are at the present time no less than fifteen† accepted species of *Glossopteris* in the Australasian Coal-measures alone; in the Indo-Chinese Gondwana Formation eighteen, and perhaps more; and in the Karu Formation of S. Africa, six. So they must remain, until the fortunate discovery of specimens similar to the present enables us to gradually reduce the multiplicity of species by learning more about the leaf-attachment, or association of one with the other on the same caudex, to say nothing of the fructification.

## 2. Description of the Specimen.

Turning now to the specimen, we see the remains of a small caudex or stem, surmounted by a clump of closely packed fronds, with ample traces on the former of the previous existence of

* Dana. Wilkes U.S. Explor. Exped. x. (Geology), 1849, p. 716.

† We do not include *G. ovata*, Johnston, in this enumeration, as it seems to be little more than a variety of *G. ampla*, Dana; neither are varieties of other species counted.

many others. The whole of the organic matter has been removed, nor is the slightest trace of any hard epidermal envelope remaining, leaving only the impression of the parts on the slab of fine sandstone forming the matrix.

The caudex is represented by a matrix-cast, reposing in its own impression, six inches long, and in its compressed state three-quarters of an inch in width. It is covered from end to end with cicatrices, or leaf-scars, that will be described later on. The fronds are attached in a clump at the upper or younger end, to the number of about eight, in various states of completeness, but only one of them can be said to be entire. The manner in which they overlap one another leads us to believe that these fronds were not placed in a vertical, but spirally on the caudex, after the manner of a tree-fern, and the appearance of the leaf-scars supports this view.

The fronds are elongately-lanceolate, apparently sessile, and without any evidence of the existence of a long petiole. There is the impression of a strong persistent mid-rib, and secondary veins that curve outwards obtusely and gradually. Commencing on the right-hand of the specimen (Pl. XVIII. fig. 1), an entire leaf is followed by the broken base of a second. In a line with the latter, but above and separated by matrix, and clearly passing underneath it to a lower level on the caudex, is a third frond ; adjoining the third leaf, although not seen to articulate with the caudex, is a fourth and broader frond, slightly overlain on the left side by the fifth, which shows the most satisfactory evidence in the whole series of stem-attachment. Following this to the left are portions of certainly three others, and possibly a fourth, most of them showing traces of a downward prolongation towards the caudex.

The first and best preserved leaf on the right, although by no means the widest, is five and three-quarter inches long, and three-quarters of an inch wide. The partially preserved fourth frond is one and a quarter inches in width.

From the method of the fossil's preservation, the retention of the mesh formed by the reticulation of the secondary veins, is but

very faintly visible, although under a low power lens it can be caught in certain lights on the narrow frond on the right-hand. The secondary veins, so far as they can be made out, leave the mid-rib at an obtuse angle, curving gradually outwards, and for quite half their distance are simple. The mesh then occupies the other half of the frond, and forms an acutely rhomboidal net-work. The lower portion of all the leaves in which that part is visible shows a transversely puckered or wrinkled surface. This is not structural, but arises, in all probability, from pressure.

The upper end of the caudex is rounded. The cicatrices, or leaf-scars, seen on its impression (Pl. XVIII. fig. 2), seem to be ovo-rhomboidal, arranged alternately, or in oblique rows. The internal cast, lying loosely in its impression, bears on its surface a number of ill-preserved rod-like projections (Pl. XVIII. fig. 3), that in all probability represent the vascular bundles. Some of the leaf-scars, more particularly when taken by a wax mould, show the scars of three vascular bundles to the cicatrix. The lower portion of the internal cast bears a series of concentric undulations, which are probably superinduced (Pl. XVIII. fig. 4).

Now, the facts we learn from a study of this specimen are the following :—

1. A general confirmation of Dana's (and possibly McClelland's) description of the mode of attachment of the fronds, so far as it was known to them.

2. The leaves did not merely form a clump at the growing end of the root-stalk, but were successively developed along the whole course of the latter, and were deciduous.

3. The leaves were both petiolate (Dana's) and sessile (Pl. XVIII. fig. 1, Pl. XIX. fig. 1), or probably sub-sessile.

4. The leaf-scars were probably ovo-rhomboidal, and to each there appear to have been three bundles of vessels.

### 3. The structure of the Genus *Glossopteris*.

The genus was founded by A. Brongniart, on fronds received both from India and Australia, which he described as *G. browniana*, var. *indica*, and var. *australasica* respectively.* It includes simple petiolate leaves, varying in shape from elongately-elliptical, oblong-elliptical, widely ovate, and spathulate to lingual-lanceolate, and possessing a generally strong and frequently striate mid-rib, sensibly attenuating upwards, and at times reaching the apex, or even evanescing a short distance before attaining the top of the leaf. The secondary veins emerge from the mid-rib usually at an acute angle, and by frequent anastomosis form a very characteristic, elongately-hexagonal network, extending over the whole or only a portion of the frond. The fronds attain a large size, for McCoy mentions those of *G. browniana* as six inches in width, and probably reaching a length of two feet.† Brongniart imagined that the reticulation of the secondary veins was confined to near the mid-rib, but this erroneous view was corrected by Morris,‡ who pointed out the distribution of the mesh at times over the whole surface.

Of such simple leaves has *Glossopteris* been supposed by all but two writers to be composed, the existence of the so-called species depending on the outline of the leaf and form of the net-venation. It seems to have escaped the notice of subsequent writers that Dana figured§ a number of fronds of *Glossopteris*, believed to be *G. browniana* var. *australasica*, attached in a clump to a fragment of stem. Zigno expressed the opinion, so Bunbury states,‖ that this species had a compound or digitate frond, and quoted a report that a specimen had been found to establish the fact. This, how-

* Hist. Vég. Foss. 1828, i. p. 223.

† Ann. Mag. Nat. Hist. 1847, xx. p. 151.

‡ Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 247.

§ Wilkes, U.S. Explor. Exped. x (Geology), 1849, p. 716, Atlas, t. 12, f. 13C.

‖ Quart. Journ. Geol. Soc. 1861, xvii. p. 327.

ever, Bunbury doubted, and said that nothing in the Indian examples, examined by him, showed them to be otherwise than simple fronds. Bunbury also stated* that Dr. McClelland, in one of his Indian Geological Survey Reports (1850), figured a *Glossopteris* that might at first sight be supposed to show a digitate frond, "but on examination of the drawing [McClelland's], it is clear that the leaves did not all grow in the same plane, and that instead of being leaflets of a digitate frond, they are really single fronds growing in a tuft (as is so common in recent ferns) from a short thick rhizoma." Dana says of his very interesting specimen, "fronds formed a clump, as is common now with numerous ferns, especially those of warmer climates. The foot-stalk into which the frond tapers is very long, quite equalling, in the young individual, the old frond. . . . . At least twenty fronds were clustered together in the clump and probably others."† The figure given by Dana exhibits seventeen or eighteen stipes radiating *apparently* from a common level, like a vertical. Only two portions of fronds remain, but the perfect one possesses a definite strong mid-rib. The fronds had evidently been converted into a black carbonised film, and in consequence the venation is not apparent. Many of the petioles or stipes are very long, as much as one and a-quarter inches in one case. The object to which the petioles are attached is seen obliquely and looks like a section of a caudex. It is manifest that this is not precisely the arrangement or method of union visible in our specimen, now under discussion. In this case, as before explained, the fronds are sessile, and placed one above the other on the caudex.

We may now turn our attention to the latter, and compare the structure of that of our specimen with some remarks of Prof. McCoy's.‡ He says—"I believe I have ascertained the rhizoma of this species [*G. browniana*], which is furnished with ovate, clasping (or at least very convex) subcarinate scales, having a

* *Ibid.* p. 328.

† Dana, *loc. cit.* p. 716.

‡ Ann. Mag. Nat. Hist. 1847, xx. p. 151.

divaricate reticulate neuration, resembling that of the parent frond, but much less strongly marked; these scales are of large size, some of them being nearly an inch in length, and terminating at the apex in a long flat linear appendage, about one line in width, which occasionally gives off small, lateral, flat, membraneous branches, nearly at right angles." Here, again, it is clear that no useful comparison can be made with the new specimen, for we have not observed any structure at all corresponding to this.

Before proceeding to discuss the highly important question of fructification, it is absolutely necessary to have a clear perception of Brongniart's constitution of *Glossopteris*. Of the four species described by him,* the only one we are at present concerned with is his *G. browniana*, the type, but of this two varieties are mentioned. The first is var. a. *australasica*, the second var. b. *indica*. By the laws of nomenclature, therefore, should it become necessary to separate these varieties generically, it is to the var. a., or the Australian form, that the name *Glossopteris* would have to be restricted. Schimper, on the other hand, in his great work, the "Traité de Palaeontologie Végetale,"† constitutes the var. b., or the Indian plant, the type of the genus, and restricts the two varieties of Brongniart under their respective names as species. In this he was afterwards followed by Feistmantel.‡

Now, the earliest indication of fructification in *Glossopteris* was seen by Brongniart on var. b. *(indica)*, in the form of what he believed to be the scars of large, rounded, sessile capsules, or sori, arranged at intervals, in a subserial manner, near the margins of the frond.§ For many years this was all that was known of the fruiting of *Glossopteris*, but in 1861 Bunbury published‖ similar figures of the Indian plant to Brongniart's, exhibiting small round spots subserially arranged parallel to the frond margin.

* Hist. Vég. Foss. 1828, i. p. 223.

† Vol. i. 1869, p. 645.

‡ Pal. Indica (Gondwana Flora), 1879, iii. Pt. 1, p. 100.

§ Hist. Vég. Foss. 1828, i. p. 224.

‖ Quart. Journ. Geol. Soc. 1861, xvii. p. 327, t. 8, f. 1 and 4.

He says on this point:—"The position of the fructification is indicated in several of the specimens by small round spots, very regularly arranged in one or two rows parallel to the margin—the outermost row at but a short distance from the margin, the inner about half-way between the outer and the mid-rib. When there is only one row it is always the inner that is wanting. In these spots I can find no organic structure at all, but only little lumps of sandstone, as if not only the sori themselves, but the very substance of the frond had decayed, or been displaced at these points. I think, however, from the regularity of their form and arrangement, there can be little doubt that they really indicate the places of the sori." Acting on this belief, Bunbury suggested an alliance of *Glossopteris* to the Polypodidæ or Aspideæ, but at the same time suggested that the venation of the fronds indicated a tendency towards the Acrosticheæ.

The next step in advance was made by Mr. William Carruthers, who detected on some Queensland examples of *Glossopteris*, collected by the late Richard Daintree, indications of fruiting,* in the form of linear sori, running along the secondary veins, and nearer to the margin than to the mid-rib. Unfortunately, no one has had the good fortune, notwithstanding the thousands of examples of *Glossopteris* that have been collected, to notice a similar structure, but the result of this discovery was at once grasped by Feistmantel, who pointed out that it would necessitate, if confirmed, the placing of the Australian and Indian plants in separate genera.† Feistmantel considered the Queensland *Glossopteris* to resemble the living *Anthrophyum*, an opinion in which he is supported by Zeiller,‡ but Tenison Woods states§ that *Anthrophyum* is devoid of a mid-rib, and therefore the comparison would not strictly stand. It appears to us, however, that there is a rudimentary mid-rib in *Anthrophyum* (or *Antrophyum*)

* Quart. Journ. Geol. Soc. 1872, xxviii. p. 354.
† Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 97.
‡ Ann. des Mines, 1882, Livr. Sept.-Oct.
§ Proc. Linn. Soc. N. S. Wales, 1883, viii. 121.

extending but a short distance into the substance of the frond.* No doubt Feistmantel's comparison of the fructification of the two ferns was a very appropriate one.

Feistmantel also believed † he had discovered traces of a third kind of fructification in the Indian *G. angustifolia*, Brong. On the frond referred to there existed a clear space along each margin, "which perhaps shows that in fertile fronds the fructification is a marginal one." We would here suggest a comparison with the genus *Schizoloma* amongst recent ferns. He generally confirmed Brongniart and Bunbury's observations on the fruiting of *G. indica*, and gave some excellent additional figures of similar sorus scars in *G. communis*, Feist.

In lending provisional support to these views, Zeiller remarked on the absence of any hitherto discovered sporangia, and says that provided the foregoing evidences of fructification are sound, it is difficult to doubt the presence of the three groups proposed by Feistmantel. Their conjoint opinion may be briefly expressed thus :—

Group 1.—Type of *G. browniana*, Carruthers, allied to genera of living ferns, such as *Anthrophyum*, with linear sori on the nervules.

Group 2.—Type of *G. indica*, Schimper (*G. browniana*, var. b. *indica*, Brong.), allied to genera of living ferns, such as *Polypodium*, with round sori in longitudinal rows parallel to the frond margin.

Group 3.—Type of *G. angustifolia*, Feistmantel (? *G. angustifolia*, Brong.), with a supposed marginal fructification along the edge of the frond, as in the living genus *Pteris*.

Now, there is one weak point in this classification. We have already pointed out that, according to strict priority, should any division of *Glossopteris* be necessary, it is to Brongniart's

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* *See* Beddome's Ferns of Southern India, 1863, t. 52.

† *Loc. cit.* p. 97, t. 39a, f. 1 and 2.

var. a. *australasica* that the generic name should be applied. But it is this very variety that is unprovided for in the triple subdivision, simply because the fruiting was not apparent in the original specimens received by Brongniart from Australia. To which division, therefore—that with the round sori, that with the linear sori, or that with the supposed marginal fructification, is Brongniart's var. a. *australasica*, to be referred? As a corollary to this arises the question—which of the three sections is *Glossopteris* in its restricted meaning?

We may tentatively dismiss Group 3 from consideration, for two reasons. It was one of the after species described by Brongniart, and we have no knowledge of its existence in Australia, but it certainly will hereafter require a name to distinguish it by.

The general question is further complicated by Mr. John Mitchell's discovery of what he believes to be the typical form of Indian fructification on a *Glossopteris* frond from the Newcastle beds, at Lake Macquarie Road, near Charlestown. He lately exhibited to this Society,* the leaf in question, an impression without organic film, showing two rounded bodies and the indication of a third. We are indebted to Mr. Mitchell for the loan of this specimen, and freely admit that in their serial arrangement they correspond to those scars described by Brongniart, and figured by the latter and Feistmantel, but the objects themselves do not convey to us the idea of sori. We must, however, bow to the evidence such as it is, and it would thus appear that we have in Australia *Glossopteris*-like leaves possessing two out of the three forms of fructification.

In answer to the question put by ourselves in a preceding paragraph—which of the three sections is *Glossopteris?* the course that best commends itself to us is, in this particular instance, to overlook strict priority and follow Schimper in selecting the var. b. *indica* as the type of the genus, and restricting the name *Glossopteris* to those forms that, like the latter, are provided with

* Proc. Linn. Soc. N. S. Wales, 1892, vii. (2), Pt. 3, p. 377.

round serially arranged sori, leaving those with the fructification placed in a linear manner along the secondary nerves, and typified by the *Glossopteris* described by Mr. Carruthers from Queensland, as the type of a new genus, should researches in the future furnish additional examples with similar structure. Again referring to a tabular form the classification will stand thus :—

Group 1.—*Glossopteris*, Brongniart. Type, *G. browniana* var. *indica*, Brong. (*G. indica*, auct.). Sori round, sessile, subserial, near the margin of the frond.

India and Australia.

Group 2.— ? . Type, *G. browniana*, Carruthers (*non* Brong.). Sori linear, sessile, along the secondary veins (and nervules ?).

Australia (Queensland).

Group 3.— ? . Type, *G. angustifolia*, Feistmantel (? *G. angustifolia*, Brong.). Fructification marginal, on a clear space along the margins of the fronds.

India.

With regard to that large body of leaves described under various names, and without evidence of fructification, it will be convenient to write them as *Glossopteris*, followed by a note of interrogation, until their true affinity shall become known. Amongst these will naturally fall the specimen from near Mudgee described in this paper.

### 4. Relation of the Mudgee Specimen to *Glossopteris* (Auct.)

We may now perhaps profitably engage ourselves with the consideration of how far the Mudgee specimen (Pl. xviii. fig. 1, Pl. xix. fig. 1) corresponds in structure with that of *Glossopteris*, as generally understood. On comparison with Dana's remarkable figure we have to note the petiolate leaves of the latter, and their apparently sessile condition in the former. All forms of *Glossopteris* are petiolate, in a greater or less degree, generally the former, and many highly so. That the fronds in Dana's illustration are

devoid of net-venation is of small consequence, for they are apparently carbonised, with all trace of the venation lost, a by no means uncommon condition in these ferns. Notwithstanding these discrepancies, that the clump of leaves terminating our specimen are those of *Glossopteris* as ordinarily understood, we do not anticipate any impartial critic will attempt to deny, the combined form and characters of the mid-rib and venation being sufficient. As to the form of the leaves, they belong to the lanceolate division of the genus, as opposed to the spathulate, and oblong-elliptical sections, and practically resemble in outline those of *G. linearis*, McCoy,* or *G. Clarkei*, Feist.† The mid-rib is glossopteroid in the strictest sense of the word, extending quite to the apex of each leaf; whilst the venation, although differing, so far as we have been able to make it out, from that of *G. linearis*, by the simple nature of the secondary veins, when first issuing from the mid-rib, is obviously like that of *G. Clarkei*.

Touching the caudex, little can be said from a comparative point of view, for Dana's figure shows no structure hereabouts, whilst McCoy's description being that of a stem detached from leaves cannot carry any great weight with it, more particularly as he uses the term rhizome, in this case a rather ambiguous one. A rhizome, according to Balfour,‡ is "an underground stem which creeps horizontally or obliquely under the surface of the soil, and terminates in an aërial stem." Moore,§ on the other hand, says—"The caudex, sometimes called the rhizome or root-stock, is often erroneously regarded as the root. It is, however, a modified stem, and assumes, in the case of ferns, two very distinct appearances, sometimes lengthened and creeping, either beneath or upon the surface of the earth, and sometimes short and tufted, forming little more than a crown, whence the fronds issue." McCoy's description, we imagine, refers to a creeping stem as defined by

* Ann. Mag. Nat. Hist. 1847, xx. p. 151, t. 9, f. 5, 5*a*.
† Mem. Geol. Survey N.S. Wales, Pal. Series No. 3, 1890, p. 123, t. 13, f. 4.
‡ Manual of Botany, 3rd Edit. 1855, p. 692.
§ Handbook of British Ferns, 1848, p. 3.

Balfour, whilst our example more nearly accords with the latter portion of Moore's diagnosis. On the whole, therefore, we see no reason to doubt that we are dealing with a true *Glossopteris*, irrespective of the question of fructification.

As to the specific identity of the Mudgee fossil we offer no decided opinion, beyond the fact that it undoubtedly comes near to *G. linearis*, McCoy, in the general habit of the leaves, and *G. Clarkei*, Feist., in the venation. A further remark will also be found on this subject at the end of Section 6 *(Sagenopteris)*.

### 5. Relation of *Glossopteris* to *Gangamopteris*.

*Gangamopteris*, although proposed by Sir F. McCoy as a generic term in 1860,* was described in 1875† and is characterised by a simple, or impari-pinnate frond, the pinnules, or leaflets, varying from oblique-ovate to trigonal, spathulate, or flabelliform. The base is petiolate or oblique and adherent, or wide and embracing, but McCoy says never auriculate. There is no mid-rib, but the principal veins, at first parallel with one another and thick, are united by small more or less horizontal cross veins that alternately evanesce into the general substance of a frond. Many of the secondary veins arise direct from the base, others from the primary veins in the usual way, and after dichotomisation towards the margin, anastomose to form an irregular network or mesh.

The mode of attachment of the fronds to the caudex is not known, but McCoy considered that by their varied obliquity the plant was probably impari-pinnate.

The chief difference relied on to distinguish *Gangamopteris* from *Glossopteris* is the character of the mid-rib, "the place of which [in the former] is occupied by numerous dichotomous nerves."‡ No doubt, in thoroughly typical species of both genera this distinction holds good, such as *Glossopteris browniana* on the one hand and

* Trans. R. Soc. Vict. for 1860 [1861], p. 207, *note*.

† Prod. Pal. Vict. Dec ii. 1875, p. 11.

‡ Ann. Mag. Nat. Hist. 1847, xx. p. 149.

*Gangamopteris obliqua* on the other, but Feistmantel has figured some forms of *Glossopteris*, such as *G. tæniopteroides*,* *G. intermittens*,† in which the mid-rib seems to be dissolved into a series of parallel veins; whilst in his *Gangamopteris Clarkei*‡ there is an entire absence of the cross reticulating veinlets of the typical mid-rib of that genus. Neither will the non-auriculate base of the fronds in *Gangamopteris* wholly stand good as a differential character, for Feistmantel says that in *Gangamopteris cyclopteroides*, var. *subauriculata*,§ the base is partially auriculate. The same observer also figures another transitional form in his *Glossopteris decipiens*,‖ from the Lower Gondwana formation, wherein the secondary veins occupying the top portion of the frond closely resemble those in a similar position on the leaves of *Gangamopteris*.

It is, therefore, questionable how far the two genera, except in extreme species, can be separated. At the same time, it cannot be denied that on a casual glance the two genera have a very different appearance, and it will perhaps be better to regard the points of differentiation as those of a broad general, rather than of a minutely morphological nature. This view does not, of course, take into consideration the habit of growth, which may ultimately prove to be of a widely different character.

### 6. Relation of *Glossopteris* to *Sagenopteris*.

According to Schenk,¶ in *Sagenopteris*, Presl., the frond consists of four hardly petiolate leaflets, carried on a cylindrical stem, whilst later the same Author** says these are arranged in two pairs.

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* Mem. Geol. Survey N.S. Wales, Pal. Series, No. 3, 1890, p. 128, t. 18, f. 1.

† Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 99, t. 33*a*, f. 2-4.

‡ Mem. Geol. Survey N.S. Wales, Pal. Series, No. 3, 1890, p. 123, t. 20, f. 3.

§ Pal. Indica (Gondwana Flora), 1879, iii. Pt. 1, p. 13, t. 15, f. 1 and 3.

‖ Pal. Indica (Gondwana Flora), 1879, iii. Pt. 1, p. 17, t. 18, f. 3, 4, 5.

¶ Foss. Flora Grenzsch. Keupers-Lias Frankens, 1867, p. 59.

** Zittel's Paléontologie (Fr. trans.), Pt. ii.—Paléophytologie, Pt. 1, 1891, p. 150.

Possibly one of these pairs is displayed in *Sagenopteris tasmanica*, Johnston.* The leaflets vary in shape from lanceolate to elliptical and obpyriform. On the other hand, Fontaine† describes five leaflets in *Sagenopteris* from the Potomac younger Mesozoic Flora. Lindley and Hutton‡ figure one example of *S. Phillipsii* with four lanceolate fronds forming a clump, sessile in one case, sub-petiolate in another. Their second figure exhibits oval leaves. In *S.* (?) *longifolia*, Feist.,§ the fronds are increased to six in number, lanceolate, and again possessing the same fingered arrangement at the end of a small caudex, but in this case sessile. Again, in *S. polyphylla*, Feist.,‖ if this really be a *Sagenopteris*, an additional leaflet is present, making seven, and in this instance petiolate. The mid-rib is visible in the lower part of each, but is rapidly dissolved into the secondary veins, which branch at a tolerably acute angle and anastomose to form a network of elongated meshes, described by Schimper¶ as hexagonal-rhomboidal. In reality the mesh is polymorphous, and even variable on the same frond. Both Schimper** and Schenk†† agree in describing the leaflets as coriaceous. The centre leaflets are usually longer than those at the side, and more or less obovate, whilst the latter are elliptical and unequal-sided.†† In his five pinnule frond Fontaine says that the right and left outermost leaflets are the smaller, which practically agrees with Schenk's observations. Or, the whole may be elliptical or even lanceolate. Feistmantel§§ believed that the

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* Feistmantel, Mem. Geol. Survey N.S. Wales, Pal. Series, No. 3, 1890, t. 29, f. 6.

† Mon. U.S. Geol. Survey (Powell's), 1889, xv.

‡ Foss. Flora, i. p. 63, t. 63.

§ Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 113, t. 40a, f. 1.

‖ *Ibid.* p. 113, t. 41a, f. 3 and 4.

¶ Traité Pal. Vég. 1869, i. p. 640.

** *Ibid.* p. 640.

†† Zittel's Paléontologie (Fr. trans.), Pt. ii.—Paléophytologie, Pt. 1, 1891, p. 150.

‡‡ Schenk, Foss. Flora Grenzsch. Keupers-Lias Frankens, 1867, p. 59.

§§ Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 114.

somewhat oblique shape of the outer segments in certain of his Indian forms indicated that they belonged to a fingered leaf. There is no doubt that the arrangement of these segments is characteristic of the plant, and the fact is well defined by Morris,* who remarks that the four or five pinnules arise in a flabellate form from a common rachis.

The fructification was unknown to Schenk at the time of his earlier writings, but later† he describes the fruit as spherical or oval, and smooth or hirsute. Nathorst‡ also discovered what he believed to be the fruit of *Sagenopteris undulata*, in the Swedish Mesozoic beds, as small spherical bodies plentifully scattered throughout the shale.

Lindley and Hutton,§ in figuring both the lanceolate and oval leaves of their *S. Phillipsii*, suggested that the longer leaves of their Fig. 2 might be the fruit-bearing, and the oval fronds the barren.

Touching the relation of *Sagenopteris* to *Glossopteris*, Bunbury‖ long ago, agreeing with Zigno, doubted the wisdom of their separation. He remarks—"Notwithstanding the difference in the composition of the frond between the typical species of *Glossopteris* and *Sagenopteris*, I yet agree with De Zigno in doubting whether the two genera are sufficiently distinct. In specimens of *Sagenopteris Phillipsii* from Scarborough, I find the venation so similar to that of the Australian *Glossopteris*, that it would be very difficult to found a generic difference upon this character. . . . The fructification of *Sagenopteris* is still entirely unknown; and it is possible that, when discovered, it may prove the two genera to be quite distinct." Schenk¶ retained

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* Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 247.

† Zittel's Paléontologie (Fr. transl.), Pt. ii.—Paléophytologie, Pt. 1, 1891, p. 151.

‡ Floran vid Bjuf, 1878, i. p. 26, t. 5, f. 1.

§ Foss. Flora, i. t. 63, f. 1 and 2.

‖ Quart. Journ. Geol. Soc. 1861, xvii. p. 328.

¶ Beiträge zur Flora der Vorwelt. *Palaeontographica*, xvi. Heft 6, p. 222.

them distinct, although with evident reluctance, chiefly on account of the simple non-pinnate leaf in *Glossopteris*.

The margins of the leaflets are not always entire in *Sagenopteris*, Nathorst having described a species, *S. dentata*,* in which they are largely dentate. Notwithstanding that this is uncommon in *Sagenopteris*, so far as our experience has gone, nothing of the sort occurs in *Glossopteris*, and probably between us we have examined many thousand specimens.

That the mid-rib in *Glossopteris* does evanesce before reaching the apex of some leaves is equally true, such for instance is the case in *G. longicaulis*, Feist.,† but in general it is at about the last fourth towards the apex and often less that the mid-rid commences to dissolve into the secondary veins. On the other hand, in all the short and broad-leaved forms of *Sagenopteris* the mid-rib disappears low down, and even in a limited number of cases it is difficult to detect more than the rudiment of a mid-rib. The latter is the case in Nathorst's *S. undulata*,‡ Fontaine's *S. rhoifolia*,§ and Schenk's *S. Mantelli*,‖ from the Wealden Coal-measures of Osnabrück. But in some long-leaved species of *Sagenopteris, e.g.*, *S. Phillipsii*, Phill., from the Yorkshire Oolite, figured by Lindley and Hutton,¶ the mid-ribs resemble those in *Glossopteris* leaves, and are strong and persistent almost to the apices. Also in *S. polyphylla*, Feist.,** there is a strong mid-rib, whilst in another plant referred provisionally to *Sagenopteris* by Feistmantel under the name of *S. (?) longifolia*,†† this vein extends almost to the apex. In fact *Glossopteris longicaulis*, Feist., and *Sagenopteris (?) longifolia*, Feist., may be regarded as transitional forms between

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* Floran vid Bjuf, 1878, i. t. 2, f. 5-7.

† Pal. Indica (Gondwana Flora), 1881, iii. Pt. 1, Suppl. p. 53, t. 31, f. 1, 3.

‡ *Loc. cit.* t. 2, f. 4.

§ Mon. U.S. Geol. Survey (Powell's), 1883, vi. t. 49, f. 5.

‖ Beiträge zur Flora der Vorwelt, Pt. 4, p. 20, t. 10, f. 5.

¶ Foss. Flora, i. p. 63, t. 63.

** Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 113, t. 41a, f. 3 and 4.

†† *Loc. cit.* t. 40*a*, f. 1.

the two genera. As a rule the leaflets of *Sagenopteris* are much smaller than those of *Glossopteris*, but in *S. göppertiana*, Zigno,* they are large and very *Glossopteris*-like.

From the foregoing remarks it is manifest how difficult it is to distinguish between the fronds of the two genera, if the venation is alone relied on, except in extreme forms of either.

Amongst the species at present included by authors in *Sagenopteris* there are three distinct types in the form and method of attachment of the leaves :—

*a.* Leaves elliptical or obpyriform, sessile, or hardly petiolate, *e.g.: Sagenopteris rhoifolia*, Presl., (the generic type) ; *S. goeppertiana*, Zigno ; *S. undulata*, Nath.

*b.* Leaves lanceolate, petiolate, *e.g. : Sagenopteris Phillipsii*, L. and H.

*c.* Leaves lanceolate, sessile, *e.g.: S. (?) longifolia*, Feist.

With regard to the first section, when the leaves are found attached to the stalk, as is very frequently the case, the whole facies of the plant, *plus* its venation, is so manifestly different from our present fossil that we do not think there need be any doubt of the distinctness of the two.

As to the second section, the matter is not so clear. There the form and arrangement of the leaves, together with the more or less persistent mid-rib, are so markedly that of our Mudgee plant (Pl. XVIII. fig. 1) that one is led to doubt the wisdom of separating the latter from it, were it not for the petiolate nature of this section. On the other hand, the sessile condition of the leaves in the Mudgee fossil distinctly allies it to the third, or section *c*. After all, as in so many other instances, generic separation will probably have to depend on the fructification when that shall become more thoroughly known. For this, however, we must await further discoveries.

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* Flora Foss. Form. Oolithicæ, i. p. 188, t. 22, f. 1 and 2.

A few words may now be said about the stems of our Mudgee fossil and *Sagenopteris*. That of the former has already been described, but so far as we have been able to ascertain the caudex properly speaking of *Sagenopteris* is unknown, the leaves or fronds being attached at the end of a long leaf stalk, and as described by Count von Solms-Laubach,* "spring from the same point." Such is certainly the case in *S. polypyhlla*, Feist., *S. rhoifolia*, Presl., *S. elongata*, Braun, &c. On the other hand, the caudex or leaf stalk in *S. (?) longifolia*, Feist., certainly has a roughened appearance, which may have been caused by leaf scars, or it may only be due to fossilisation. Feistmantel has figured† a "fern-rhizome" from the Karharbari Coal-field, ascribed to a *Neuropteris*, covered with rhomboidal scars, possessing a generally indistinct spiral arrangement, and not unlike those of our *Glossopteris*, but without fronds attached.

The general resemblance of our Mudgee *Glossopteris* to Feistmantel's *Sagenopteris (?) longifolia*,‡ in every detail, except the form of the venation and number of leaves, is remarkable, with a clump of six sessile lanceolate leaves at the end of a small leaf stalk.

### 7. Relation of *Glossopteris* to *Anthrophyopsis*.

The latter of these names was applied by Nathorst§ to certain portions of simple leaves, either lanceolate, or wide and round, with anastomosing veins forming a longitudinally rhombic-hexagonal mesh. The above Author remarks that it differs from *Glossopteris* in the absence of a mid-rib, but possibly Feistmantel‖ is more correct in suggesting a closer alliance to typical species of *Gangamopteris*. In the absence of the central portion of the frond it is difficult to discuss the systematic position of *Anthro-*

* Fossil Botany (Engl. Transl. by Garnsey and Balfour), 1891, p. 138.

† Pal. Indica (Gondwana Flora), 1879, iii. Pt. 1, p. 18, t. 13, f. 6.

‡ Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 113, t. 40a, f. 1.

§ Floran vid Bjuf, 1878, i. p. 43.

‖ Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 115.

*phyopsis*, but the best of Nathorst's figures* conveys the impression of a leaf in which the veins did not pass from a mid-rib, supposing it possessed one, after the manner of *Glossopteris* or *Gangamopteris*, but rather as in *Macrotæniopteris*, practically horizontal and at right angles. One very characteristic feature about these Swedish leaves is that the rhombic-hexagonal venation of the mesh is confined to one side of the leaves, probably the outside or marginal portion. On that part of the leaf contiguous to the mid-rib, if it existed, the veins are simple and parallel to one another.

In his Fig. 4† Nathorst represents a series of very regular punctæ, in a single line, within the boundaries of each rhombic-hexagon of the mesh. Supposing these to represent fructification, we know nothing like it in *Glossopteris*. Fontaine, however, figures the supposed fructification of his *Sagenopteris elliptica*,‡ as small elevations or dots, in the substance of the mesh between the anastomosing veins.

### 8. Relation of *Glossopteris* to *Dactylopteris*.

Ottokar Feistmantel, the describer of *Dactylopteris*, assigns to it a digitate frond of six or more sessile or petiolate leaflets on a common stalk. The leaflets are lanceolate, with a mid-rib in the basal portions dividing upwards into anastomosing secondary veins forming a polygonal or oblong mesh.§

It is difficult to understand how, on this definition, *Dactylopteris* differs from *Sagenopteris*, unless it be by the number of leaflets on the frond, and the more defined condition of the mid-rib. Even Feistmantel does not appear too positive, for he simply remarks that *Sagenopteris* "has somewhat different characters."

The genus was provisionally proposed for the two species already mentioned as *Sagenopteris longifolia* and *S. (?) polyphylla*. In

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* *Loc. cit.* t. 7, f. 3.

† *Loc. cit.* t. 7, f. 4.

‡ Mon. U.S. Geol. Survey (Powell's), 1889, xv. p. 149, t. 27, f. 15, 15a.

§ Pal. Indica (Gondwana Flora), 1881, iii. Pt. 3, p. 113.

the former the leaves are sessile, in the latter elongately petiolate; in the one case forming a clump, like our Mudgee fossil, in the other an open-leaved pinna. The name may perhaps be retained for *S. (?) polyphylla* with advantage, but hardly for *S. (?) longifolia*; the latter in this sense corresponds to the third section into which we have divided *Sagenopteris*.

## 9. General Conclusions.

After due consideration of the facts passed in review, we are led to the following general conclusions.

1. For simplicity' sake, and in common with Schimper, Feistmantel, and others, it is more convenient to restrict the name *Glossopteris* to fronds after the type of *G. browniana* var. *indica*, Brong.

2. In common with the Indian plant described by McClelland, the Australian form from Mudgee possessed leaves growing in a clump at the end of a caudex, and did not form a digitate pinna.

3. The Australian Glossopterids possessed both sessile and petiolate leaves, the latter condition being in the majority.

4. It is impossible to define the number of sessile leaves in a clump, owing to their deciduous nature; and as regards the petiolate condition we do not yet know sufficient about it to dogmatise.

5. Of the three states of fructification known in leaves so far referred to *Glossopteris*, we possess two in Australia.

6. The Mudgee fossil is allied to two Australian forms of *Glossopteris*, viz., *G. linearis*, McCoy, and *G. Clarkei*, Feist.; to the one by general habit, and to the other by the character of its venation.

7. The Mudgee fossil in its long lanceolate and sessile leaves, continuous mid-rib, &c., bears a strong resemblance to the 3rd section of *Sagenopteris*, typified by *S. (?) longifolia*, Feist.

8. As pointed out by Zeiller, no trace of sporangia has yet been met with in *Glossopteris*, so far as we have been able to ascertain.

9. Eliminating the habit of growth, of which we know nothing definite in *Gangamopteris*, it is questionable how far the leaves of the two genera *Glossopteris* and *Gangamopteris* can be separated, except in extreme cases.

10. It is evident that those leaves of *Sagenopteris*, possessing a moderately developed mid-rib, such as *S. elongata*, Br., are with difficulty separated from those of transitional species of *Glossopteris*, but once such leaves referred to *Sagenopteris* are seen attached to their leaf-stalk, or it is permitted to observe the fructification, the separation is possible.

11. We have no leaves in Australian rocks exactly analogous to *Anthrophyopsis*, Nath.

12. In all probability it will be necessary to separate Feistmantel's *S. (?) polyphylla* from *Sagenopteris*, and restrict *Dactylopteris* for its reception. It presents the additional peculiarity of possessing the secondary veins all of one order.

## 10. Stratigraphical Distribution of *Glossopteris* in Australia.

*Glossopteris* is known to occur in Queensland, N. S. Wales, and Tasmania. It has also been recorded from New Zealand, but hitherto its occurrence in that country cannot be considered to be an established fact. As regards the occurrence of *Glossopteris* there, Sir James Hector says*—"At the base of the Kaihiku Series are the *Glossopteris* beds of Mt. Potts." To these Kaihiku beds he assigns a Permian age, but the range of the genus *Glossopteris* is stated to extend into the higher Wairoa Series of Triassic age. On this Sir James remarks†—"In some districts the Wairoa Series is divided into two horizons, yielding marine fossils, separated by sandstones containing fossil plants

* Indian and Col. Exhib. N. Zealand Court, Geol. Cat. and Guide, 1886, p. 77.

† *Ibid.* p. 74.

from which forms of *Glossopteris*, *Zamites*, and *Rhacophyllum* have been obtained." There is no reference, however, to the occurrence of *Glossopteris* in the fossil flora of New Zealand in Baron von Ettingshausen's masterly paper—"Contributions to the knowledge of the Fossil Flora of New Zealand."*

Writing to one of us on Feb. 26th of this year Captain Hutton states—"I still think that *Glossopteris* has not been found in New Zealand. We have no Palæozoic flora." The earliest statement as to the occurrence of a plant, alleged to be *Glossopteris*, in New Zealand is contained in Reports of Geological Explorations, New Zealand, 1868-1869, p. iii.

In Tasmania *Glossopteris* occurs in marine strata of Permo-Carboniferous age south of Hobart at Adventure Bay, South Bruni, where in company with *Gangamopteris* it is associated with a seam of coal, two feet in thickness.†

In the Mersey Coal-field, near Latrobe, *Glossopteris* is met with in abundance in the shaly-beds of the thin productive Coal-measures, which are there capped by marine strata of Permo-Carboniferous age. It is associated with *Gangamopteris* and with leaves of *Nöggerathiopsis*.

At the above localities the age of *Glossopteris* in Tasmania is undoubtedly Palæozoic. According to the following statements, however, *Glossopteris* possibly ascends into Mesozoic strata in that island. In 1874 the late R. B. Smyth published a note‡ to the effect that he had discovered at Spring Hill, near Hobart, a leaf of *Glossopteris browniana* associated on the same piece of shale with the characteristic Mesozoic fern, *Alethopteris australis*, "from the south-eastern part of Tasmania," and thus from the Upper or Mesozoic Coal-measures. This plant has never been figured to the best of our knowledge, and the strange association remained unconfirmed until Mr. R. M. Johnston described another fern

‡ Trans. N. Zealand Inst. 1891, xxiii. p. 42.

§ R. M. Johnston. Geology of Tasmania, p. 143 (Govt. Printer, Hobart, 1888).

* Second Geol. Survey Vict., Progress Report i. 1874, p. 24.

from a similar horizon at Lord's Hill, New Town, Tasmania, under the name of *Glossopteris (?) moribunda.** Mr. Johnston states† with regard to this fossil—"I have discovered two fragments of a small species associated with the common Mesozoic forms at the shaly beds at Lord's Hill, New Town. It is not certain that they may yet prove to be a form of Sagenopteris, as their bases were both imperfect. The largest fragment is 42 millimetres long, 13 millimetres at its broadest part near the top, and 9 millimetres at the base of fragment, to which it gradually tapers; mid-rib distinct, from which branch off at an acute angle about 12 principal nerves in the length of fragment. These nerves, after acutely ascending from the mid rib, curve and branch outward dichotomously and flexuously, forking two or three times before reaching margin, anastomosing at each fork. The meshes, however, are more open than in the larger forms of *G. browniana* from the lower coal-measures, and the nerves appear to be more raised and wrinkled. The frond itself appears to be more coriaceous and fleshy.

"As indicated by the measurements, the frond is somewhat linear-spathulate in form. In the smaller specimens the spathulate appearance is far less pronounced. They are unlike any description given of *Sagenopteris rhoifolia* or *S. Tasmanica*, and apart from the circumstance that their bases and mode of insertion are unknown, they seem to me to be more akin to the genus Glossopteris to which they have been provisionally referred. It would appear, therefore, that these rare forms are the dwarfed or degraded descendants of that genus which gave such a peculiar character to the shales of the lower coal-measures by its wonderful profusion, and are an indication of the fast approaching extinction of the genus in Australian rocks." Mr. Johnston states‡ that Mr. Wintle informed him that he discovered some years previous to 1886, near the same spot (Lord's Hill, New Town, Hobart), "a

* Proc. R. Soc. Tas. for 1886 [1887], pp. 161 and 169-170.
† *Loc. cit.* pp. 169-170.
‡ *Loc. cit.* p. 162.

form which he considered to be identical with *Glossopteris browniana.*"

If Messrs. Smyth and Wintle's statements are correct, and if Mr. Johnston's plant be a true *Glossopteris,* it must be admitted that the genus ranges into the Australasian Mesozoic beds, but it is more than probable that *G. (?) moribunda* is only a lanceolate *Sagenopteris* after the type of Feistmantel's *S. (?) longifolia.* We can only reiterate Mr. Johnston's wish to see the supposed *G. browniana* critically examined and figured.

In Victoria *Glossopteris* has never yet been discovered, as far as is known to us. Strata perhaps homotaxial with some of the *Glossopteris*-bearing beds of Tasmania, New South Wales and Queensland are known to occur at Bacchus Marsh and Wild-duck Creek. At the former locality *Gangamopteris* is represented by four species.*†

In New South Wales *Glossopteris* occurs in profusion in the productive Coal-measures of Permo-Carboniferous age, and, as far as at present known, it is wholly restricted in this Colony to that horizon. The fact, however, should be mentioned that Sir F. McCoy has recorded *Glossopteris* from the rocks of Arowa, in New South Wales, the age of which is Carboniferous, and therefore considerably older than that of the typical Permo-Carboniferous rocks.‡

He states that *G. linearis* is "not uncommon" at the above locality. This alleged occurrence, however, has not yet been confirmed, and no instance is known to us in New South Wales of *Glossopteris* being associated with either *Lepidodendron* or *Rhacopteris,* though these last two are abundant in the local Carboniferous Flora.

The Permo-Carboniferous System of New South Wales in the type district comprises in descending order the following divisions :—

* Sir F. McCoy, Prod. Pal. Vic. Dec. ii. 1875, pp. 11-13, Pl. 12 and 13.
† Selwyn, Phys. Geog. Geol. and Min. Vict. 1866, p. 16.
‡ Ann. Mag. Nat. Hist. 1847, xx. p. 152.

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|---|---|
| Newcastle Coal-measures | Upper Marine Series |
| Dempsey Beds | Greta Coal-measures |
| Tomago Coal-measures | Lower Marine Series |

The total thickness of this system is between 10,000 and 11,000 feet.

*Glossopteris* ranges from near the top of the Lower Marine Series to the top of the Newcastle Coal-measures.

The oldest fossil plant at all related to *Glossopteris* at present known to us is represented by somewhat imperfectly preserved leaves in a fine grained sandstone, in the Lower Marine Series, near Lochinvar.

This horizon is probably over 2000 feet below the top of the Lower Marine Series and the base of the Greta Coal-measures. The leaves, which have not yet been figured or described, appear to resemble *Gangamopteris* rather than *Glossopteris*. The lowest horizons from which undoubted *Glossopteris* has been obtained in New South Wales are (1) near Farley (Stony Creek), West Maitland, a few hundred feet below the base of the Greta Coal-measures; and (2) at Nicholson's Quarry on the Hunter River, about three miles above Belmore Bridge, West Maitland.

In the Greta Coal-measures *Glossopteris* is very abundant and is associated with almost equally abundant *Gangamopteris*, *Nöggerathiopsis*, and *Vertebraria*. It occurs most plentifully in the clay shales forming the floors and roofs of the productive coal-seams. At Richmond Vale, near East Maitland, as already described by one of us,* *Glossopteris* leaves have been found with so much of their original organic structure preserved as to be quite flexible. Many of the leaves were rolled up by the mechanical action of water, but after they had been treated for a few hours in glycerine it was found possible to unroll them to their full original length.

* T. W. E. David. Proc. Linn. Soc. N.S. Wales, 1890, v. (2), Pt. 3, pp. 424-426.

*Glossopteris* occurs sparingly in the Upper Marine Series, fragments of wood referred to *Araucarioxylon* being the only other kind of plant known to be contemporaneously interbedded in the same series.

In the Tomago Series *Glossopteris* is still largely associated with *Gangamopteris*, but in the Dempsey and Newcastle Coal-measures, while *Glossopteris* is very abundant, *Gangamopteris* appears to be somewhat rarer.

At Joadja Creek and at Hartley Vale, *Glossopteris* leaves occur contemporaneously interbedded in kerosene shale, on the horizon of the Newcastle Coal-measures. Kerosene shale has been determined by Professors Bertrand and Renault in their interesting and able memoir just published* to be chiefly formed of the alga *Reinschia australis*.

At Joadja Creek *Glossopteris* is frequently found in company with *Vertebraria*, the former being horizontal in position, the latter almost invariably vertical. *Glossopteris* leaves have been observed to form portion of the coal in the Bulli Coal-seam in the Illawarra District on the horizon of the Newcastle Coal-measures.

The horizon from which the specimen which forms the subject of this paper was obtained, is probably that of the Newcastle Coal-measures, the locality being in the Western Coal-field. The fossil was found by Mr. C. J. Horsley, J.P., on the Wollar Road, then (1890) in course of construction, on the southern fall of "The Gap," about seventeen miles from Mudgee. The finder generously gave it to Mr. N. J. C. MacTaggart, B.E., of the Water Conservation Branch, Public Works Department, who presented it to the Geological Museum, University of Sydney. A note on its occurrence has already been contributed by one of us.† *Glossopteris* has never been found in New South Wales in

* Reinschia Australis et premières Remarques sur le Kerosene Shale de la Nouvelles-Galles du Sud, par MM. C.-Eg. Bertrand & B. Renault. Autun. Imprimerie Dejussieu, Père et Fils. 1894.

† T. W. E. David. Proc. Linn. Soc. N.S. Wales, 1893, viii. (2), Pt. 2, p. 218.

association with any Mesozoic plants such as *Tæniopteris* or *Thinnfeldia*. If, therefore, we reject the doubtful case of the *Glossopteris* from Arowa, presumably of Carboniferous age, mentioned by Sir F. McCoy, *Glossopteris* is exclusively Permo-Carboniferous in its range in New South Wales.

In Queensland *Glossopteris* occurs in the Middle and Upper Bowen Series, in both of which it is associated with a Marine Permo-Carboniferous fauna. It is of Palæozoic age at the Bowen River Coal-field; at the Dawson River Coal-field; at Peak Downs, Townsville; Oakey Creek, near Cooktown; and the Little River Coal-fields, Palmer River. Until lately it was considered to be wholly of Palæzoic age in Queensland as in New South Wales. As far back, however, as 1872, the late Mr. Norman Taylor (formerly of the Geological Survey of Victoria), identified *Glossopteris* leaves from a hill south of the Mitchell River, in the Cape Gold-field, Queensland, in a formation subsequently considered to be Upper Cretaceous, but which he at the time considered to be Permo-Carboniferous. In 1890, Mr. Rands discovered *Glossopteris in situ* at Betts' Creek, Cape Gold-field, in rocks considered by him to belong to the Desert Sandstone, and therefore to be of Upper Cretaceous age.*†

In July, 1891, Mr. R. L. Jack, F.G.S., the Government Geologist of Queensland, confirmed Mr. Rands' opinion as to the horizon where his specimens were obtained being in Upper Cretaceous rocks.‡ With the exception of the reference just given relating to the Cretaceous age of *Glossopteris* in Queensland, as far as the Authors are aware the only other statement as to *Glossopteris* being of Post-Jurassic age is contained in a quotation by the late Dr. Ottokar Feistmantel § from Trautschold, who described ‖ a leaf like that of *Glossopteris*, with a

* Report on the Cape Gold-field, p. 10. Brisbane. By Authority, 1891.
† Jack and Etheridge, Junr. Geology and Palæontology of Queensland, p. 518.
‡ Geology, &c., of Queensland, p. 519.
§ Mem. Geol. Survey N. S. Wales, Pal. Series, No. 3, 1890, pp. 119-120.
‖ Nouv. Mém. Soc. Imp. Nat. Moscou, xiii. p. 221.

faint anastomosis of the veins in the lower portion, from the Russian Klinische Sandstone of Cretaceous age. This leaf Trautschold terms *Glossopteris solitaria*; and again, a leaf figured by Visiani and Massolongo, from the Tertiary beds of Novale, in Italy, which Feistmantel says, if correctly figured, cannot be a *Glossopteris*. The above Authors name this plant *G. apocynophyllum*. On the other hand, Schenk states that no form of *Glossopteris* is found in Europe.*

*Glossopteris* has not yet been recorded from South Australia, including the Northern Territory. In South Australia no rocks of Permo-Carboniferous age have as yet been identified. In Western Australia, however, Permo-Carboniferous rocks have been proved to exist at the Irwin River, from which locality several marine fossils have been enumerated by one of us.†

Quite recently Mr. B. H. Woodward, Curator of the Geological Museum at Perth, has forwarded a named collection of fossils from the Gascoyne River to the Geological Survey of New South Wales. Amongst these are two pieces of dark shale displaying perfectly distinct leaves of *G. browniana*. We believe that this is the first recorded instance of the occurrence of *Glossopteris* in that Colony.‡

Our present knowledge of the geographical distribution and geological range of *Glossopteris* in Australasia may be briefly summarised as follows :—It is extremely doubtful whether *Glossopteris* ever existed in New Zealand. In Eastern Australia during the Permo-Carboniferous Period *Glossopteris* having a form resembling that of a dwarf tree fern flourished abundantly in the great swamps of the coast and portion of the inland areas of

* Zittel's Paléontologie (Fr. trans.), Pt. II., Paléophytologie, Pt. 1, 1891, p. 130.

† R. Etheridge, Junr., Ann. Rept. Dept. Mines, N. S. Wales, for 1889 [1890], p. 239.

‡ We find, however, that in the "Western Australian Year Book" for 1892-93, p. 241 (8vo. Perth, 1893), it is stated that Mr. R. Etheridge, F.R.S., detected "portions of *Glossopteris* or *Nœggerathia* in coal, submitted to him from the Collie River Coal-field, W.A."

Eastern Australia, ranging from near Cooktown, in Queensland, to South Bruni, in Tasmania, a range in latitude of over 1900 miles. To this may be added the isolated occurrence on the Gascoyne River in West Australia.

No evidence has as yet been obtained to show that *Glossopteris* ever flourished in South Australia or in the Northern Territory.

As regards its geological range, one doubtful locality has been cited by Sir F. McCoy, that of Arowa, in New South Wales, where its age may possibly be Carboniferous rather than Permo-Carboniferous; but on the other hand no well established case has come under our notice in which *Glossopteris* has been found in Australia in association with either *Lepipodendron* or with *Rhacopteris*. *Glossopteris* is the predominant type of plant and is enormously abundant in the Permo-Carboniferous Coal-measures of Queensland, New South Wales, and Tasmania. Three doubtful cases have been recorded from Tasmania of *Glossopteris* having been found in association with Lower Mesozoic plants, but it is possible that the plants are referable to some form of *Sagenopteris* rather than to *Glossopteris*.

In Queensland undoubted specimens of *Glossopteris* have been found on a geological horizon, which in the opinion of Mr. R. L. Jack, the Government Geologist, and Mr. W. H. Rands, the Assistant Government Geologist, belongs to that of the Desert Sandstone, and is therefore Upper Cretaceous. The locality, however, has not yet been mapped in detail, and the question of the exact geological horizon whence these specimens were obtained cannot therefore as yet be considered to have been definitely settled.

## DESCRIPTION OF PLATES.

### PLATE XVIII.

Fig. 1.—The specimen from near Mudgee, showing the attachment of the leaves to the caudex. Nat. size.

Fig. 2.—Portion of the matrix-cast of the caudex, taken from the hollow impression in Fig. 1, showing the ovo-rhomboidal leaf-scars.

Fig. 3.—The upper and decorticated surface of the matrix-cast, with small projecting rods, that are perhaps the casts of the vascular bundles.

Fig. 4.—Another portion similar to Fig. 3, with concentric undulations, probably super-induced.

PLATE XIX.

Fig. 1.—The upper portion of the caudex, and lower parts of the fronds, seen in Pl. I. fig. 1. Enlarged.

Fig. 2.—Portion of a frond, showing mid-rib, proximal parallel secondary veins, and distal reticulation or mesh. Enlarged.